

Space Weather Technical Forecast

Issued on Tuesday, 13 September 2022 at 13:18 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales <https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales>

Space Weather Forecast Headline: Chance of G1/Minor Storms days 2 and 4 (14th and 16th). M-class flares considered likely. Ongoing Active electron fluence.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Moderate, with a M1.7 flare observed at 12/2345 UTC. There are six sunspot regions on the disk. AR3098 in the northwest quadrant remains the largest and most complex spot, though its delta configuration has faded. AR3101 in the far northwest is also large, but as it is close to the northwest limb, detailed analysis is difficult. AR3100, is elongated but only has one significant spot. The remaining significant region, AR3102 has rotated onto the southeast limb and appears to be a large spot which may turn out to be a leader portion to a more complex region. The remaining two numbered regions are simple and relatively benign. No new Earth-directed CMEs were evident in imagery. Though there remain a slight risk of a glancing blow from a CME which left the Sun on the 11th.

Solar Wind / Geomagnetic Activity: The solar wind speed at L1 has followed a declining trend, with winds at background levels. Density was briefly moderate with a peak of 17 ppcc at 12/1439 UTC before declining to below average levels. The total magnetic field strength was weak below 6nT, with the north-south component fluctuating between +4 nT and -3 nT. Phi angle was entirely positive (away from the Sun). Geomagnetic activity was Quiet.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) as measured at GOES16, reached 6.7 pfu at 12/1405 UTC before declining back to near background by the end of the period. This is likely due to the forecast effects of a filament eruption on 11 September.

High energy electron flux varied from moderate to high. The corresponding 24-hour electron fluence remained above Active (1e8 integrated pfu) with a flat trend, resulting in a 13/0000 UTC observed value of 1.61e8 integrated pfu.

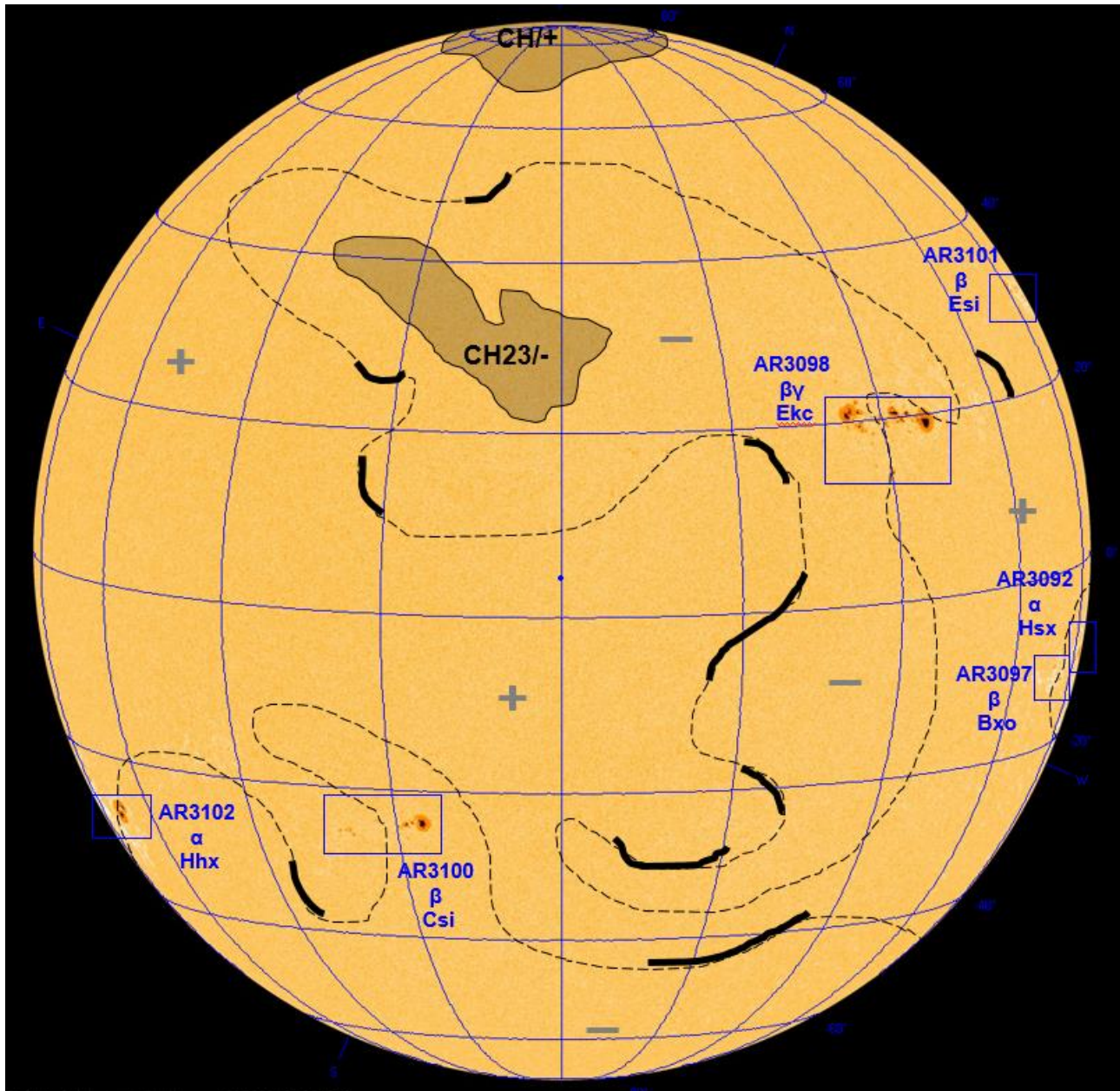
Four-Day Space Weather Forecast Summary

Solar Activity: Further M-class flares are considered likely with a very slight chance of X-class flares.

Solar Wind / Geomagnetic Activity: A CME which was observed leaving the Sun on 11 September may arrive at Earth on 13 or 14 September, although confidence is low. CH23/- may become geoeffective later on day 4 (16th), perhaps bringing elevated solar wind speeds. Geomagnetic activity is forecast to be mainly Quiet to Unsettled through the period, with Active intervals likely and a chance of G1/Minor Storms day 2 (14th) and later day 4 (16th), due to the risk of a CME arrival, then the arrival of the High Speed Stream from CH23/-, although the forecast is low confidence.

Energetic Particles / Solar Radiation: High energy protons (greater than 10 MeV) are expected to remain below S1/Minor radiation storm levels, but with a very slight chance of exceeding the threshold, due to the AR3098 complexity. The high energy (greater than 2 MeV) electron flux is currently fluctuating between High and Moderate levels. This trend is expected to ease on days 2 and 3 (14th and 15th), though the arrival of faster solar winds on the 16th may increase electron flux again. The corresponding 24-hour fluence is expected to see only a gradual decline at first in the period, but is Expected to remain above Active ($1e8$ integrated pfu) until day 2 or 3 (14th or 15th).

Figure 1. Solar Analysis Valid 13/0700 UTC.



Key: Filament ____, Prominence ____, Magnetic Field Line - - -, Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

Geomagnetic Storms:

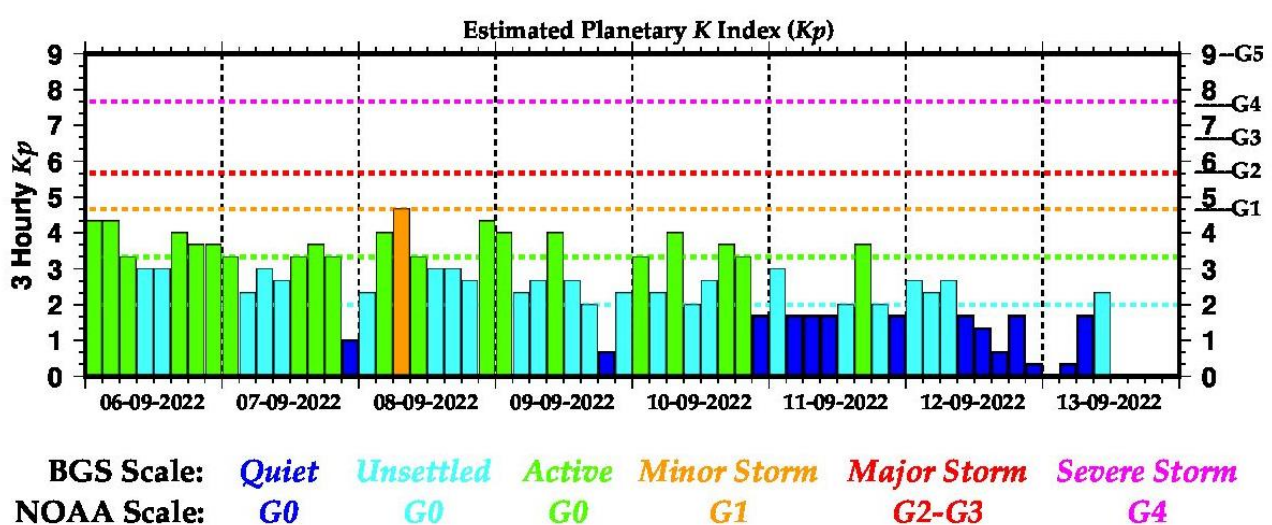
A filament eruption was observed leaving the north centre of the Sun around 11/1200UTC. STEREO A imagery although unclear indicates that a potentially Earth-directed CME has been emitted. The presumption of a CME however is supported by a sudden increase in the proton flux subsequent to the filament eruption, suggesting a 'snowplough' effect of proton enhancement ahead of a CME. In the absence of a sufficient analysis an estimate of a three day transit time would allow for an arrival on either late on 13 September or during 14 September, with a risk of G1/Minor Storms, although the forecast of arrival time or potential impacts are low confidence.

The high speed stream from coronal hole 23 is then forecast to connect with Earth late on day 4 (16th), though due to its negative polarity as we approach the autumn equinox, significant geomagnetic enhancement is thought to be unlikely.

Geomagnetic activity is forecast to be mainly Quiet to Unsettled through the period, with Active intervals likely and a chance of G1/Minor Storms day 2 (14th) and day 4 (16th), due to the risk of a CME arrival, then the arrival of CH23/-, although the forecast is low confidence.

Geo-Magnetic Storm	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Minor or Moderate	G1 to G2	No	20	30	10	30
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Figure 2: BGS Estimated Planetary K Index (Kp)



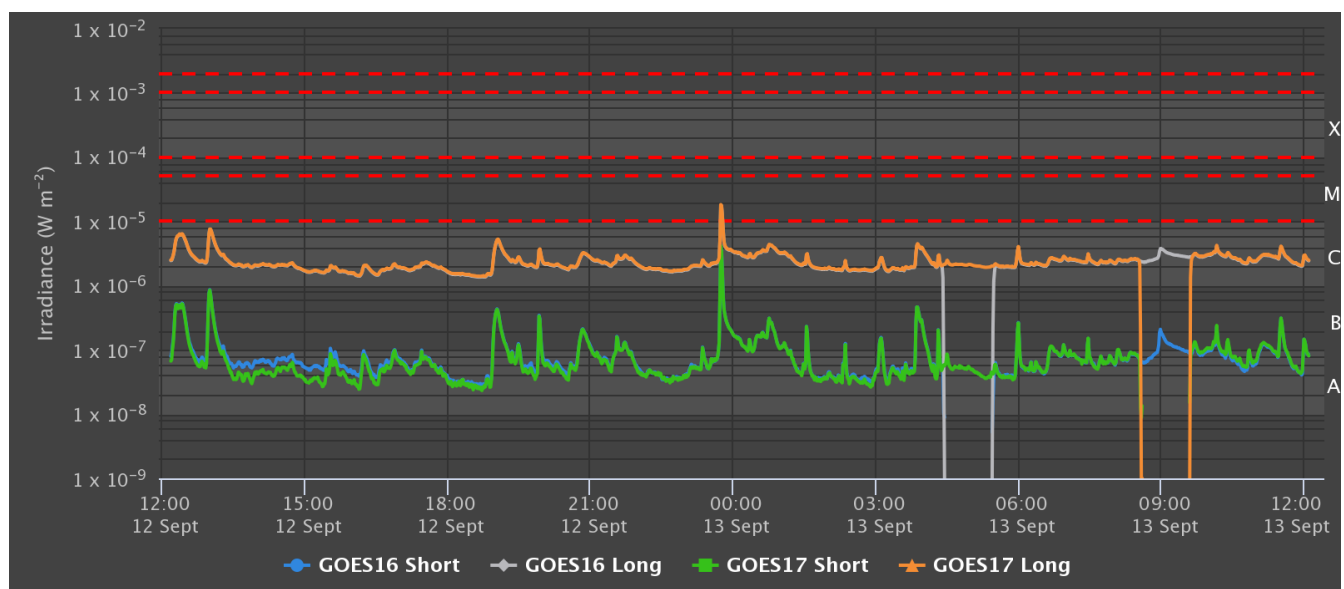
Radio Blackouts - X-Ray Flares:

The most significant sunspot region on the disc is AR3098 (Ekc/ $\beta\gamma$), this region has not produced any significant flares since the M1.7 flare at 12/2344 UTC. It may, however, have been responsible for a CME eruption on 11 September, so carries an enhanced flare risk. AR3100 (Csi/ β) in the southeast and AR3101 (Esi/ β) in the northwest are both stable, and neither has produced significant activity. However, there is the risk of enhanced activity from newly numbered AR3102 which has recently begun appearing around the southeast limb. The remaining two regions are either weak, stable, or relatively inactive.

Solar activity is expected to be Moderate with further M class flares likely and a slight chance of X flares.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	60	60	60	60
Very Active	R3 to R5 X Class	No	10	10	10	10

Figure 3: GOES16 X-Ray flares



Solar Radiation Storms - (High Energy Protons):

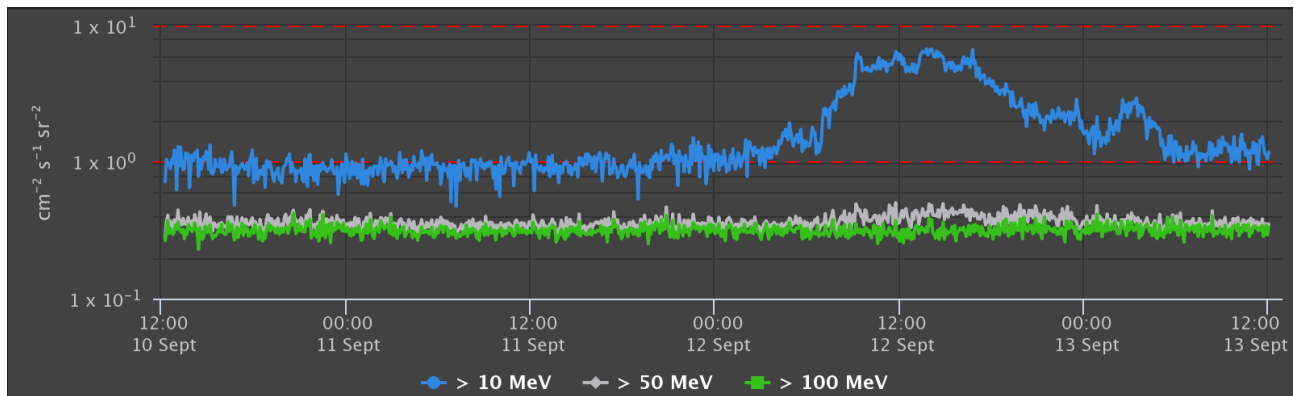
The high energy proton flux (greater than 10MeV) has undergone a marked decrease over the last 24 hours and is returning towards background levels.

Protons have now peaked, the risk of the S1 threshold being reached has now passed.

Radiation Storms	Level (cm ⁻² sr ⁻¹ s ⁻¹)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ S1	No	5	5	5	5
Very Active	≥ S3 *	No	1	1	1	1

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = cm⁻²sr⁻¹s⁻¹)

Figure 4: GOES16 PROTON Flux from the 10th September now returning to near background levels after the recent enhancement.



High Energy Electrons Event ($\geq 2\text{MeV}$):

High energy (greater than 2MeV) electron flux has varied between moderate and high levels through the last 24 hours. Otherwise, the diurnal peaks are expected to slowly fall as the radiation in the belts slowly dissipate as the solar wind eases. A potential CME arrival on either 13th or 14th September may lead to further losses due to geomagnetic enhancements, with a chance of a subsequent increase due to the injection of CME particles into the belts. A further variable is the possible arrival of CH23/- on 16th September, leading to another possible electron count reduction.

Electron fluence values are expected to follow a declining trend through the next four days, with low confidence toward the end of the period due to possible geomagnetic activity from CMEs and Coronal Hole HSS.

GEO Electron Environment	Level ($\text{cm}^{-2} \text{sr}^{-1} \text{day}^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	$\geq 2 \text{ MeV}$ $\geq 1 \times 10^8$	Yes	100	60	40	30
Very Active	$\geq 2 \text{ MeV}$ $\geq 1 \times 10^9$	No	1	1	1	1

Figure 5: GOES16 ElectronFlux diurnal maximums appear to be declining over the past 3 days.

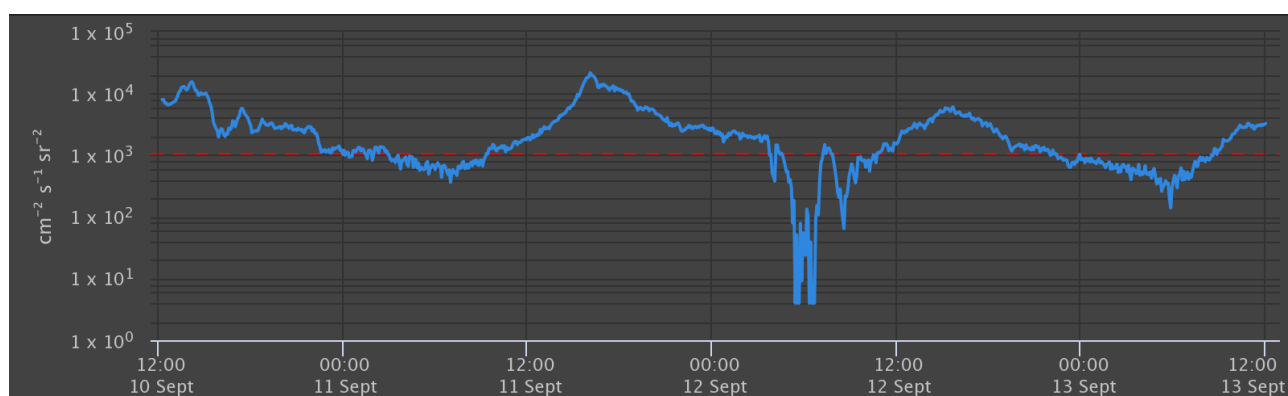


Figure 6: MOSWOC REF Model suggests a steady decline in fluence levels is likely.

